Title: Linear Functions - Learn Your Lines

Brief Overview:

> Students will collect and analyze data using motion detectors of the TI Calculator-Based Laboratory (CBL) to solve and describe if and where data, representing two straight lines, intersect using numbers, symbols, and graphs.

Links to Standards:

> • **Mathematics as Problem Solving**
> Students will us the TI-82/83 Graphing Calculator and the CBL to solve Systems of Linear Functions.

> • **Mathematics as Communication**
> Students will describe the results of the experiment using appropriate Mathematics and Scientific language usage.

> • **Mathematics as Reasoning**
> Students will extend their knowledge to analyze variations of the concepts explored.

> • **Algebra**
> Students will use either the Linear Combination or Substitution Method of solving Systems of Linear Functions as a Symbolic Method of verifying solutions found by the Graphic and/or Numeric Methods.

> • **Functions**
> Students will use a variety of modes to describe the analysis of the data collected for a System of Linear Functions.

Grade/Level:

> Algebra I with extensions in Algebra II; Grades 9-12

Prerequisite Knowledge:

> Students should have working knowledge of the following skills:

> • Graphing Linear Functions
> • Transforming Linear Functions between the Slope-Intercept and Standard Forms
> • Solutions of Systems of Functions by the Linear Combination or Substitution Methods
> • Basic TI-82/83 Operations, including the STAT mode
> • For Algebra II extension - Know how to solve for line of best-fit, using the TI-82/83 Linear Regression function

Links to Maryland High School Mathematics Core Learning Goals:

> • **Goal 1** The student will demonstrate the ability to investigate, interpret, and communicate solutions to mathematical and real-world problems using patterns, functions, and algebra.

> • **Expectation 1.2** The student will model and interpret real-world situations, using the language of mathematics and appropriate technology.

• **Indicator 1.2.3** The student will solve and describe if and where two straight lines intersect using numbers, symbols, and graphs.

Objectives:

Students will:

• work cooperatively in Groups.
• collect and organize data from the CBL, TI-82/83 and the Vernier Motion Detector.
• analyze graphs using the TI-82/83 functions to determine the intersection of two lines.

Materials/Resources/Printed Materials:

• 2 CBL Systems
• 3 TI-82/83 Graphing Calculators with unit-to-unit cables
• 2 Vernier Motion Detectors
• TI Graph Link to transfer programs MEETYOU, DATA4 (reference: Brueningsen, et al)

Development/Procedures:

• Each team of three students will begin by designating the following roles: Walker 1, Walker 2, and Recorder.

• The Recorder will pick up the worksheets: Set-Up, Running The Experiment and Graphic and Numeric Representation.

• Each team of three will set up the equipment for the experiment.

• Run the experiment, collect the data, and transfer the information to the Walker 1 Graphing Calculator.

• Transfer by Link the list L1, L2, and L3 to the other two team members.

• Record the data collected, analyze and move to the Assessment for the investigation.

Performance Assessment:

Worksheet: Learn Your Lines - Graphic and Numeric Representation

Extension/Follow Up:

Suggested areas to extend this lesson include:

• Algebra I: Learn Your Lines - Extension for Algebra. This worksheet utilizes the TRACE (Graphic) and TABLE (Numeric) functions of the TI-82/83.
• Algebra II: Symbolic Representation - use the concept of Best-Fit lines to determine the standard equation for your data lines, and solve for the intersection using either the Linear Combination or the Substitution Methods.

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Learn Your Lines
Set Up Instructions

Materials needed:
2 CBL Systems
2 TI-82/83 Graphing Calculators (with programs MEETYOU and DATA4)
2 Unit to Unit Cables
2 Ultrasonic Motion Detectors

**2 CBRs (Calculator Based Rangers) may be used in place of the CBLs and
Motion Detectors)**

Set up the CBLs and Graphing Calculators according to the diagram and written
instructions:
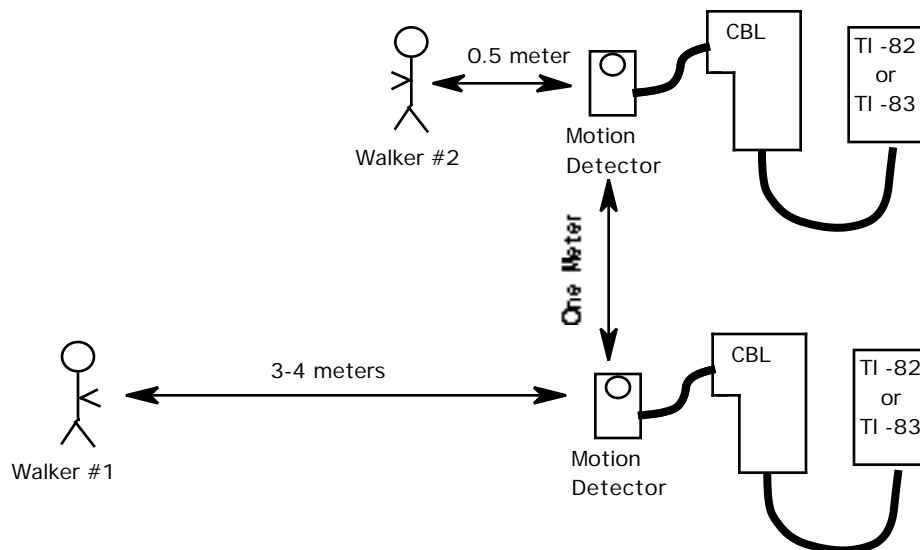
1. The graphing calculator is linked to the CBL with a unit to unit cable.
2. The motion detector is linked to the CBL using the sonic port.
3. Set the motion detector to face each person and put near the edge of the table.
   The motion detectors should be about one meter apart.
4. Walker #1 should be about 3-4 meters away from the motion detector and
   Walker #2 should be about 0.5 meter from the other motion detector.
   Walker #1 will walk toward the one detector and, at the same time, Walker #2
   walks away from the other detector.

Learn Your Lines
Running the Experiment

1. Turn on the CBL and TI-82/83.

2. Start the program MEETYOU on both graphing calculators. Choose the Exploration option from the program. Follow the instructions on the screen of the calculators. One calculator will be designated for Walker #1 and the other for Walker #2.

3. Instruct the walkers to walk at a slow and constant rate in the appropriate directions of the motion detectors. When you have completed the set up of the CBLs and calculators, the walkers should begin walking at the same time.

4. Immediately after they start walking, hit ⌷Enter⌷ on both calculators at the same time. The CBLs should "click" indicating they are collecting the data from the walkers. You will have about ten seconds to collect data.

5. When the CBLs stop clicking the data has been collected. Follow the instructions on the screen of the calculators for transferring the data.

6. If the collection and transfer of data were successful, you should have a graph similar to the one below. If your graph is not similar, try to run the experiment again.
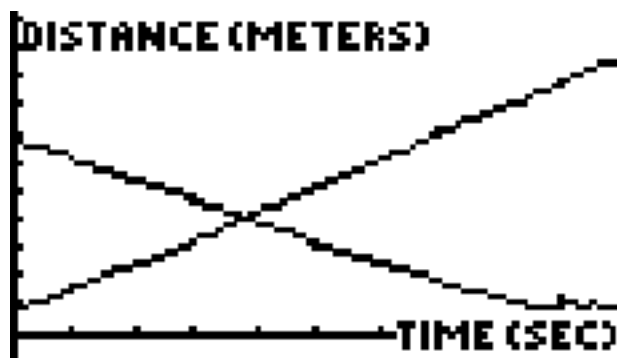
7. Use the calculator to analyze the data according to the worksheet(s).

Learn Your Lines

Graphic and Numeric Representation

1. Copy the results of your experiment from the screen of your Graphing Calculator to the screen image below. Make sure to label the graph and to give the appropriate units.

2. a) Use the $\boxed{\text{TRACE}}$ function to find the approximate intersection of the linear data.

_____

    b) What does the x value represent and what does the y-value represent in physical terms in relation to the experiment you conducted?

_____

3. Use the $\boxed{\text{STAT}}$ function and select 1. EDIT to use the data lists. In L_1 are the times in seconds, in L_2 are the distances of Walker #1, and in L_3 are the distances of Walker #2. Check the list to find the approximate point of intersection from the numeric data.

_____

4. Describe how the points of intersection found in problems 2 and 3 either verify each other or make a conclusion impossible.

_____

_____

_____

Learn Your Lines
Extension for Algebra II

5. The data collected from the CBLs and motion detectors are in L_1, L_2, and L_3 of the graphing calculators. In L_1 are the times in seconds, in L_2 are the distances of Walker #1, and in L_3 are the distances of Walker #2. Use the graphing calculator to find the line of best fit for L_1 and L_2 and store in Y_1. Find the line of best fit for L_1 and L_3 and store it in Y_2. Graph Y_1 and Y_2 along with the graphs of your data to see how they fit.   Write your two equations below rounding the slope and y-intercept to the nearest tenth.

$Y_1=$_____ $Y_2=$_____

6. Use either the Linear Combinations Method or Substitution Method to find the point of intersection of Y_1 and Y_2. Show your work below.

Point of Intersection _____

7. How does your answer in #6 compare to your answers in #2 and #3?

_____

8. State all of the different methods you could use to find the point of intersection between two lines:

_____

_____

_____

_____

Learn Your Lines

Extension - Algebra

Run the program MEETYOU on your TI 82/83 Graphing Calculator. Select the choice for Sample Data. This will load data for Walker 1 in L2 and for Walker 2 in L3. You will now see the STAT PLOT for this sample data.

Work through the following steps using the data and the functions of the TI-82/83.

1. Go to the STAT - EDIT area and look at the contents of L2 and L3.
    Note: points use the following notations.
        (L1, L2) for points on function Y1.
        (L1, L3) for points on function Y2.

2. Select the point for the time closest to 1 second for both Y1 and Y2.

    Y1   (1, ____)   Y2   (1, ____)

3. Select the point for the time closest to 10 seconds for both Y1 and Y2.

    Y1   (10, ____)   Y2   (10, ____)

4. Using the points from # 2 and #3, calculate the slope of each function.

    m of Y1 = _____   m of Y2 = _____

5. Use the slope and either point to find the y-intercept form of the function Y1 and Y2.

    Y1 = _____

    Y2 = _____

Turn the STAT PLOT off on the TI-82/83. Now enter in the functions on the Y= screen for both Y1 and Y2. Press GRAPH to display the graphs for the two functions Y1 and Y2.

6. Use the TRACE feature to estimate the intersection point for the two functions. What is this point to the nearest tenth?

   _____

7. Go to the TABLE function on the TI-82/83 and search for the L1 value where L2 and L3 are the same or very close to the same. What do these points represent?

_____

_____

   How do these points compare to the points found above in problem 6?

_____

_____

Rubric for Written Responses

Points*

  0   No response.
          Inappropriate response for data set.
          Graphic representations inaccurate or missing.
          Interpreting the algebraic answer in physical applications is
           inaccurate.

  1   Accurate graphic representation for data set.
          Use of technology in obtaining intersection is correct.
          Interpreting the algebraic answer in physical applications is
           incomplete or inaccurate.

  2   Accurate graphic representation for data set.
          Use of technology in obtaining intersection is correct.
          Interpreting the algebraic answer in physical applications is
           complete and accurate.

*Level of teacher assistance may be used to adjust rubric grades.

Rubric for Set-Up/Operations

Points

0   Off task.
         Inability to set up and complete experiment.
         Needed to use sample data set.

1   On task.
         Needed assistance for set up and/or completion of
          experiment.
         Used sample data or generated data.

2   On task.
         Worked independently to set up and complete experiment.
         Used student-generated data.